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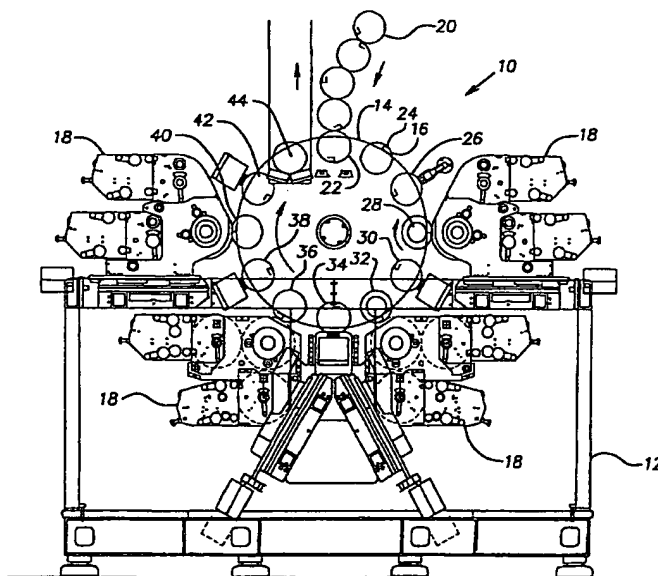
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(54) Title: MULTI-STATION PRINTING SYSTEM FOR FRUSTO-CONICAL ARTICLES



(57) Abstract: A rotating turret (14) with rotating mandrels (16) is used to move cylindrical or frusto-conical articles (20) between multi-color offset printing positions (24-42). Registration is maintained by electronic control of the indexing and speed of the mandrels (16) or the print heads (18).

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

1        MULTI-STATION PRINTING SYSTEM FOR FRUSTO-CONICAL ARTICLES

2                    BACKGROUND OF THE INVENTION

3            The present invention relates to printing on cylindrical  
4        or frusto-conical articles, and in particular multi-color  
5        offset printing on such articles.

6            Many products are packaged in cylindrical or frusto-  
7        conical containers. For example, such products include ice  
8        cream, oleomargarine, pudding, paint, sealer, detergent,  
9        chemicals to name a few. It is often desired to provide a  
10       high quality image on the exterior of these products, for  
11       example, an eight color dry offset image. Consumers in  
12       particular want to see an image of the contents of a container  
13       and high-quality graphics in general help to sell a product.

14           Heretofore, it has only been feasible to print single  
15       colors or none overlapped multiple colors on containers such  
16       as these. Instead, pre-printed labels of various  
17       configurations have been used where high quality graphics were  
18       required.

19                    SUMMARY OF THE INVENTION

20            An apparatus for offset printing on a cylindrical or  
21        frusto-conical article, said apparatus includes: a turret  
22        adapted to rotate about an axis to a plurality of print  
23        positions; a rotatable mandrel attached to the turret, the  
24        mandrel being adapted to receive the article; and at least one  
25        print head at each print position, each print head having a  
26        blanket member maintained in registration with the article and  
27        being adapted to print a different color of ink on the article  
28        when the mandrel rotates.

29                    BRIEF DESCRIPTION OF THE DRAWINGS

30            FIG. 1 is front elevation view of an apparatus according  
31        to the invention.

1 FIG. 2 is a schematic view of an offset print head.

2 FIG. 3 is a rear elevation view of a portion of the  
3 planetary gear drive for the mandrels of the invention.

4 FIG. 4 is a block diagram of a control system for an  
5 apparatus according to the invention.

6 DESCRIPTION OF THE PREFERRED EMBODIMENTS

7 Referring to FIG. 1, an apparatus 10 for printing on a  
8 cylindrical or frusto-conical article 20 includes a base 12, a  
9 turret 14, mandrels 16 and print heads 18. An article 20 is  
10 successively loaded onto a mandrel 16 at the position 22. The  
11 turret 14 is rotated to bring the article 20 to the position  
12 24 where the article is de-ionized. Next the turret 14 is  
13 rotated to bring the article 20 to the position 26 where a  
14 pretreatment such as heating is applied to the article. The  
15 turret 14 is then rotated to bring the article 20 to the  
16 position 28 where one or more non-overlapping ink colors are  
17 applied to the article 20 by a print head 18. The turret 14  
18 is then rotated to bring the article 20 to the position 30  
19 where the ink on the container 20 is cured by, for example,  
20 ultraviolet light or heat so that additional color inks can  
21 then be applied over the existing ink. The turret 14 is then  
22 rotated similarly to bring the article 20 to the positions 32,  
23 34, 36, 38, 40, 42 to apply additional color inks on the  
24 article 20. The turret 14 is then rotated to bring the  
25 article 20 to the position 44 for unloading.

26 In the preferred embodiment, the turret 14 rotates in a  
27 generally horizontal axis and the mandrels 16 rotate in  
28 respective axes that are generally parallel to the axis of the  
29 turret 14. This permits the print heads at each print  
30 position to operate in a generally horizontal orientation,  
31 which simplifies their design and operation with the use of  
32 fluid inks.

33 In the preferred embodiment each of the print positions  
34 28, 32, 36, 40 may include two print heads, each pair capable  
35 of using a different color on a common print blanket, for a

1 total of eight colors. The turret 14 may have, for example,  
2 12 mandrels.

3 Referring to FIGS. 2 and 3, at each of the print heads  
4 18, it is necessary for the mandrel 16 to rotate the article  
5 20 in proper registration with the blanket 46 of the print  
6 head 18. In the preferred embodiment, the mandrels 16 are  
7 driven by planetary gears 48 engaging a ring gear 50 rotating  
8 with respect to the turret 14. Each print head 18 is driven  
9 by a servomotor 52 that drives the blanket 46. As more fully  
10 explained below, the servomotor 52 maintains the print head 18  
11 in registration with the article 20 by matching the rotation  
12 speed of the mandrel 16 in combination with the mean diameter  
13 of the article 20 as well as proper indexing.

14 Referring to FIG. 4, a control system 60 for the  
15 apparatus 10 includes a controller 62 and sensors 64, 66, 68,  
16 70, 72. The controller 62 may be, for example, a dedicated  
17 micro-controller or a general purpose computer. The sensors  
18 64, 66, 68, 70, 72 may be, for example, optical sensors or  
19 mechanical sensors.

20 The sensor 64 senses, for example, an index reference on  
21 the article 20 or mandrel 16 at the position 24. The sensed  
22 signal is provided to the controller 62. The sensors 66, 68,  
23 70, 72 sense, for example, an index reference at each of the  
24 print positions 28, 32, 36, 40 that indicates the rotational  
25 position of each print head. The sensed signals are provided  
26 to the controller 62. Using the signals from the sensors 64,  
27 66, 68, 70, 72, the controller provides control signals to  
28 each servomotor 52 to maintain registration for the blanket 46  
29 at each print position with the article 20 being printed.

30 The apparatus 10 allows different size articles to be  
31 easily printed without any expensive and time consuming gear  
32 changes. The software of the control system 60 automatically  
33 establishes and maintains registration independently of the  
34 mean article diameter and rotation speed of the mandrels.

35 It should be noted that it would also be possible and  
36 within the scope of the invention to use a fixed gear drive  
37 for the print heads and a servomotor or motors for the

1 mandrels. It would also be possible to drive both the  
2 mandrels and the print heads with servomotors. In addition,  
3 while the preferred embodiment uses servomotors, it is also  
4 possible to use any variable speed motor with suitable  
5 position/speed feedback or an open-loop motor with a discrete  
6 response such as a stepper motor.

7 It should be evident that this disclosure is by way of  
8 example and that various changes may be made by adding,  
9 modifying or eliminating details without departing from the  
10 fair scope of the teaching contained in this disclosure. The  
11 invention is therefore not limited to particular details of  
12 this disclosure except to the extent that the following claims  
13 are necessarily so limited.

## WHAT IS CLAIMED:

1           1. An apparatus for offset printing on a cylindrical or  
2 frusto-conical article, said apparatus comprising:  
3           a turret adapted to rotate about an axis to a plurality  
4           of print positions;  
5           a rotatable mandrel attached to said turret, said mandrel  
6           being adapted to receive said article; and  
7           at least one print head at each print position, each  
8           print head having a blanket member maintained in  
9           registration with said article and being adapted to  
10          print a different color of ink on said article when  
11          said mandrel rotates.

1           2. An apparatus according to claim 1, wherein said  
2 registration is maintained by operating at least one of said  
3 mandrel and said print head by a variable speed electric  
4 motor.

1           3. An apparatus according to claim 1, wherein said  
2 registration is maintained by operating at least one of said  
3 mandrel and said print head by a digitally controlled  
4 servomotor.

1           4. An apparatus according to claim 1, wherein said  
2 registration is maintained by software control of an electric  
3 motor operable connected to said print head.

1           5. An apparatus according to claim 1, further including  
2 a curing position after each of said print positions.

1           6. An apparatus according to claim 1, having four print  
2 positions with two print heads at each print position.

1           7. An apparatus according to claim 1, having twelve said  
2 mandrels.

1           8. An apparatus according to claim 1, wherein said  
2 turret axis is generally horizontal.

1           9. An apparatus according to claim 1, wherein said  
2 mandrel rotates about an axis generally parallel to said  
3 turret axis.

1           10. An apparatus for offset printing on a cylindrical or  
2 frusto-conical article, said apparatus comprising:  
3 a turret adapted to rotate to a plurality of print  
4 positions;  
5 a rotatable mandrel attached to said turret, said mandrel  
6 being adapted to receive said article;  
7 a mandrel rotating mechanism operably connected to said  
8 mandrel;  
9 at least one print head at each print position; and  
10 a print head drive mechanism operably connected to each  
11 print head, said rotating mechanism and said drive  
12 mechanism being relatively adjustable to maintain  
13 registration with said article.

1           11. An apparatus according to claim 10, wherein said  
2 rotating mechanism is a planetary gear assembly adapted to  
3 drive a plurality of said mandrels.

1           12. An apparatus according to claim 10, wherein said  
2 drive mechanism is a variable speed electric motor.

1           13. An apparatus according to claim 10, wherein said  
2 drive mechanism is a digitally controlled servomotor.

1           14. An apparatus according to claim 10, wherein said  
2 drive mechanism is a software controlled electric motor.

1           15. An apparatus according to claim 10, wherein  
2 different mean diameter articles can be printed by software  
3 controlled adjustment of at least one of said rotating



4 mechanism and said drive mechanism to maintain registration  
5 with said different articles.

1 16. An apparatus for offset printing on a cylindrical or  
2 frusto-conical article, said apparatus comprising:  
3 a turret adapted to rotate about a generally horizontal  
4 axis to a plurality of print positions;  
5 a mandrel attached to said turret, said mandrel being  
6 adapted to receive said article and to rotate about  
7 an axis generally parallel to said horizontal axis;  
8 and  
9 at least one print head at each print position, each  
10 print head being operable in a generally horizontal  
11 orientation.

1 17. An apparatus according to claim 16, further  
2 including a curing position after each of said print  
3 positions.

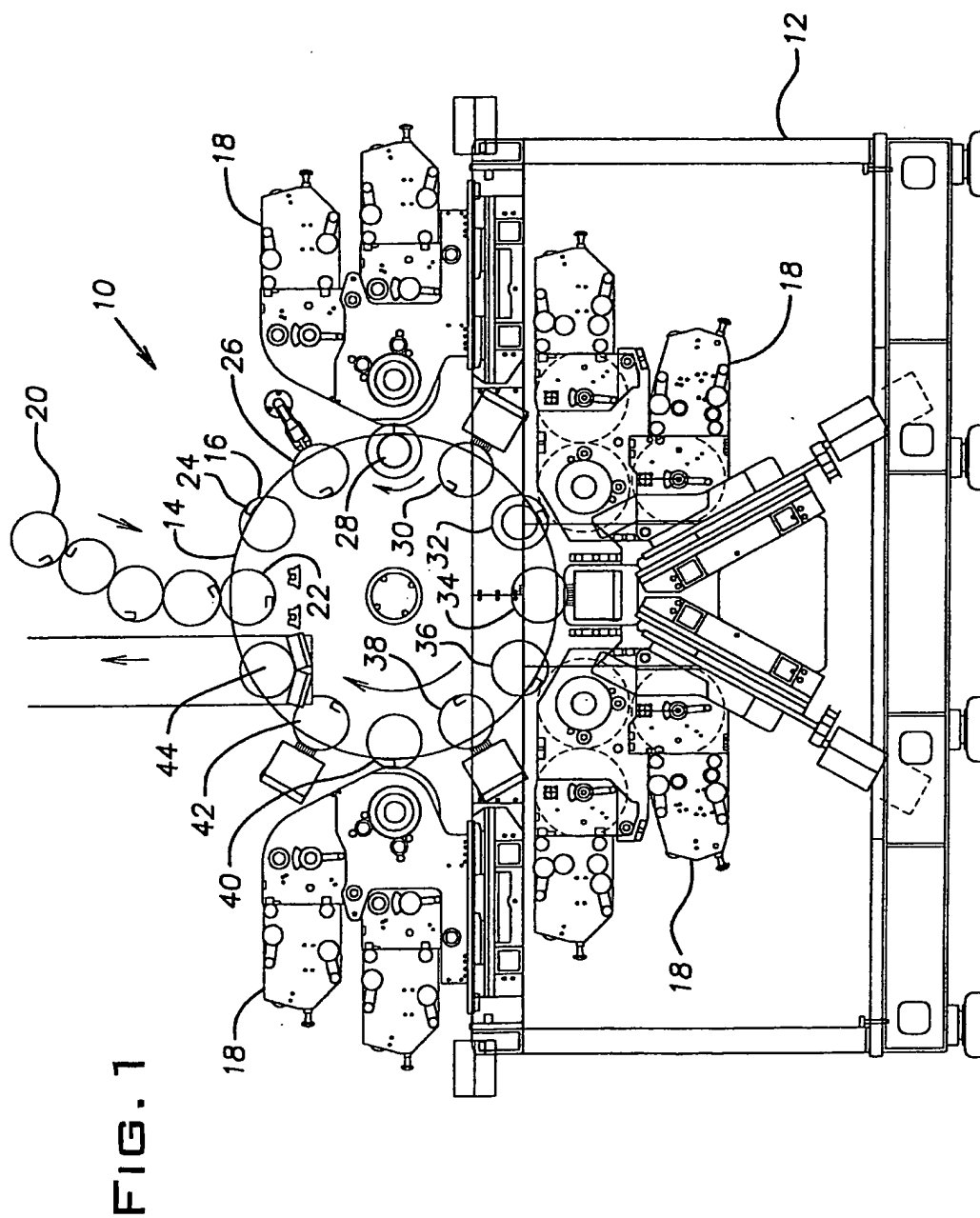
1 18. An apparatus according to claim 16, having four  
2 print positions with two print heads at each print position.

1 19. An apparatus according to claim 16, having twelve  
2 said mandrels.

1 20. A method for offset printing on a cylindrical or  
2 frusto-conical article, said method comprising:  
3 providing a turret adapted to rotate about an axis to a  
4 plurality of print positions;  
5 providing a rotatable mandrel attached to said turret,  
6 said mandrel being adapted to receive said article;  
7 and  
8 providing at least one print head at each print position,  
9 each print head having a blanket member maintained  
10 in registration with said article and being adapted  
11 to print a different color of ink on said article  
12 when said mandrel rotates.

1           21. A method for offset printing on a cylindrical or  
2 frusto-conical article, said method comprising:  
3           providing a turret adapted to rotate to a plurality of  
4           print positions;  
5           providing a rotatable mandrel attached to said turret,  
6           said mandrel being adapted to receive said article;  
7           providing a mandrel rotating mechanism operably connected  
8           to said mandrel;  
9           providing at least one print head at each print position;  
10          and  
11          providing a print head drive mechanism operably connected  
12          to each print head, said rotating mechanism and said  
13          drive mechanism being relatively adjustable to  
14          maintain registration with said article.

1           22. A method for offset printing on a cylindrical or  
2 frusto-conical article, said method comprising:  
3           providing a turret adapted to rotate about a generally  
4           horizontal axis to a plurality of print positions;  
5           providing a mandrel attached to said turret, said mandrel  
6           being adapted to receive said article and to rotate  
7           about an axis generally parallel to said horizontal  
8           axis; and  
9           providing at least one print head at each print position,  
10          each print head being operable in a generally  
11          horizontal orientation.



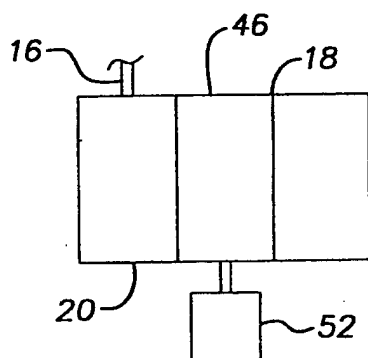


FIG. 2

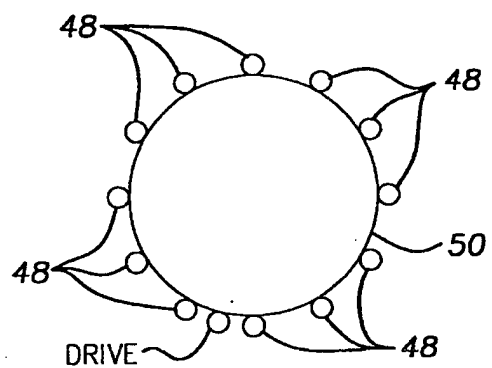


FIG. 3

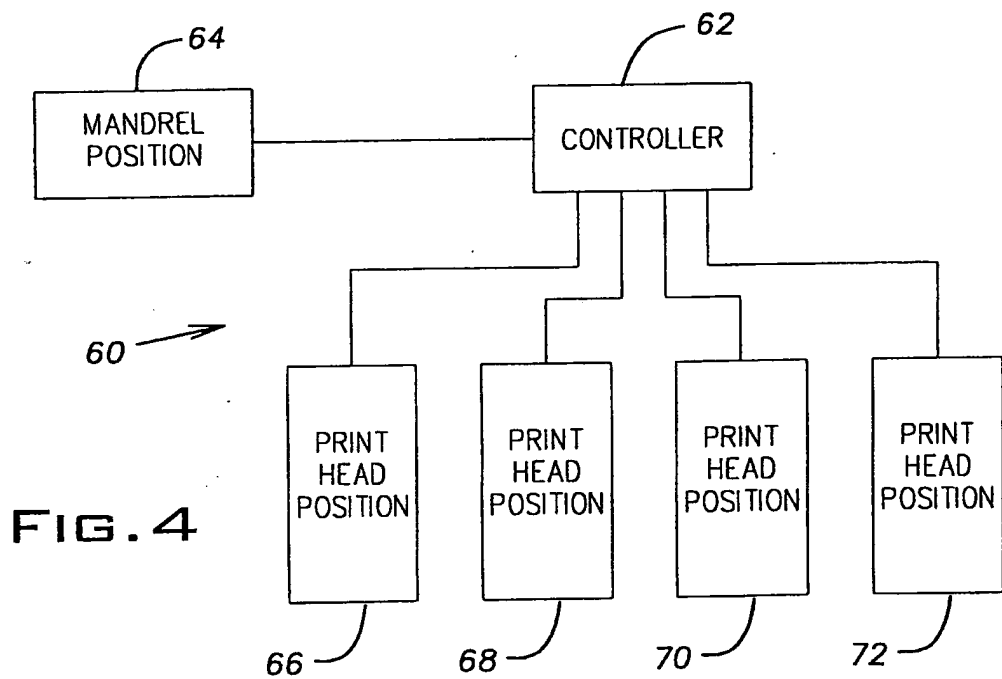


FIG. 4

## INTERNATIONAL SEARCH REPORT

 International application No.  
PCT/US00/15143

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(7) :B41F 17/00, 17/08 US CL :101/35, 36, 37, 38.1, 39, 40 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) U.S. : 101/35, 36, 37, 38.1, 39, 40 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 3,960,073 A (RUSH) 01 June 1976 (01.06.1976), see the entire document	1, 2, 5, 8-12, 15-17, 20-22 ----- 3, 4, 6, 7, 13, 14, 18, 19
Y	US 4,404,900 A (OZAWA ET AL) 20 September 1983 (20.09.1983), see the entire document	1-22
Y	US 5,193,456 A (WOLFE ET AL) 16 March 1993 (16.03.1993), see the entire document	1-22
Y	US 5,231,926 A (WILLIAMS ET AL) 03 August 1993 (03.08.1993), see the entire document	1-22
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 09 AUGUST 2000		Date of mailing of the international search report 10 OCT 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230		Authorized officer REN YAN Telephone No. (703) 308-0978

**INTERNATIONAL SEARCH REPORT**

International application No.  
PCT/US00/15143

**C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 5,970,865 A (HORTH ET AL) 26 October 1999 (26.10.1999) see the entire document	1-22